

2013 Santiago Symposium on Microgrids

Survey of Microgrid R&D in Latin America

Guillermo Jiménez Estévez
Rodrigo Palma Behnke
Microgrids Unit

Support from:

Nicolás Velásquez, UABC, MX
Antonio Sarasua, UNSJ, AR
Nicanor Quijano, UA, CO
Oscar Saavedra, UFM, BR

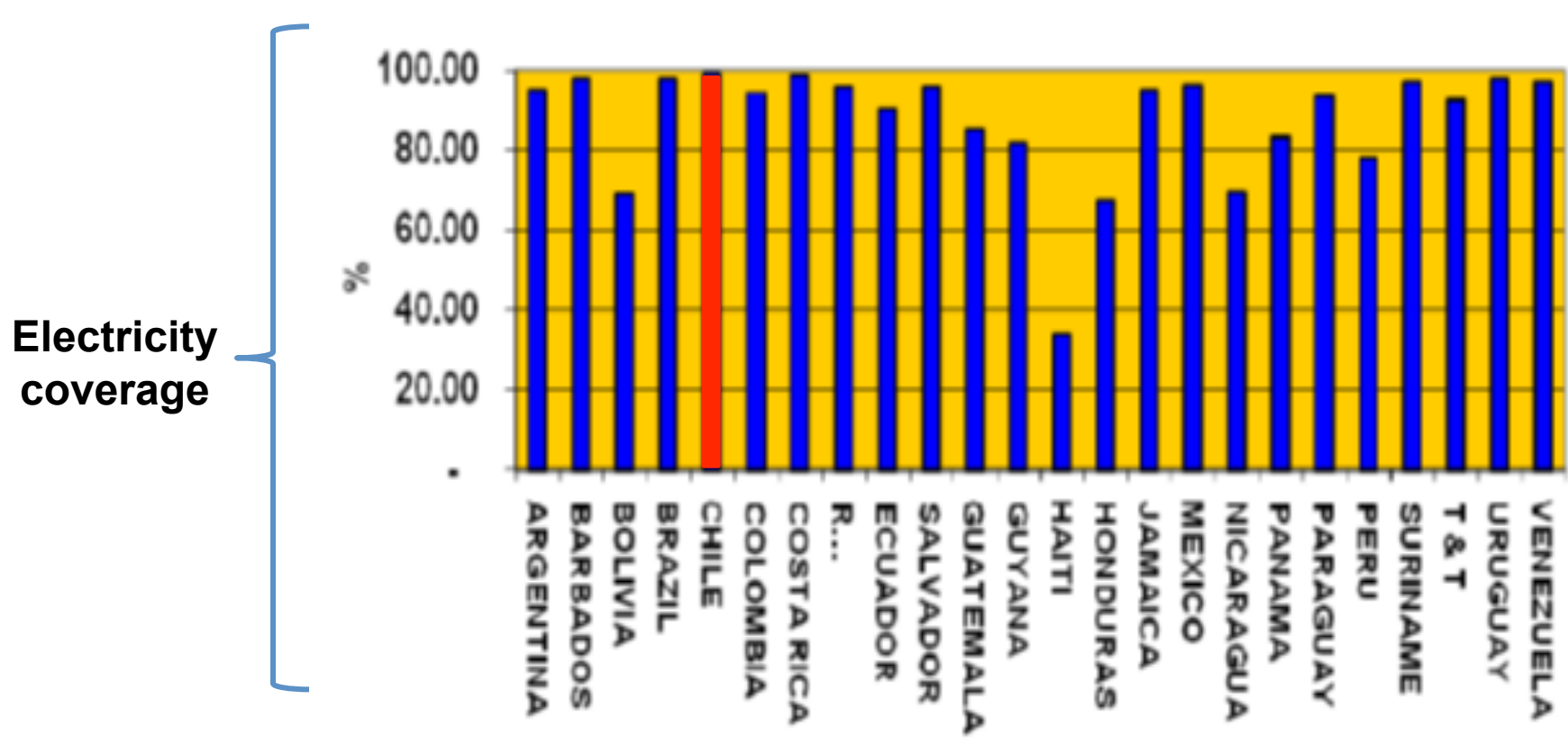
Contents

1. Microgrids opportunities and status in the region
2. Social SCADA and resilience
3. V2G in isolated microgrids
4. Conclusions

Microgrids opportunities in the region

Electricity Coverage in Latin America

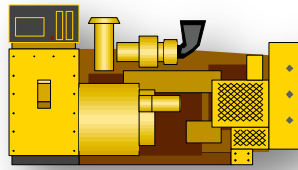
(34 mill. have no access to electricity in LA)



Source: OLADE, 2007

Microgrids opportunities in the region

Development status



RE projects fall down in providing **diesel engines** for power supply and organize the **community** in such way that they are **in charge of covering the operation and maintenance costs** of the solution. Unfortunately in the **long term** is **not possible to cover all these costs** and the **power supply is limited** to few hours per day



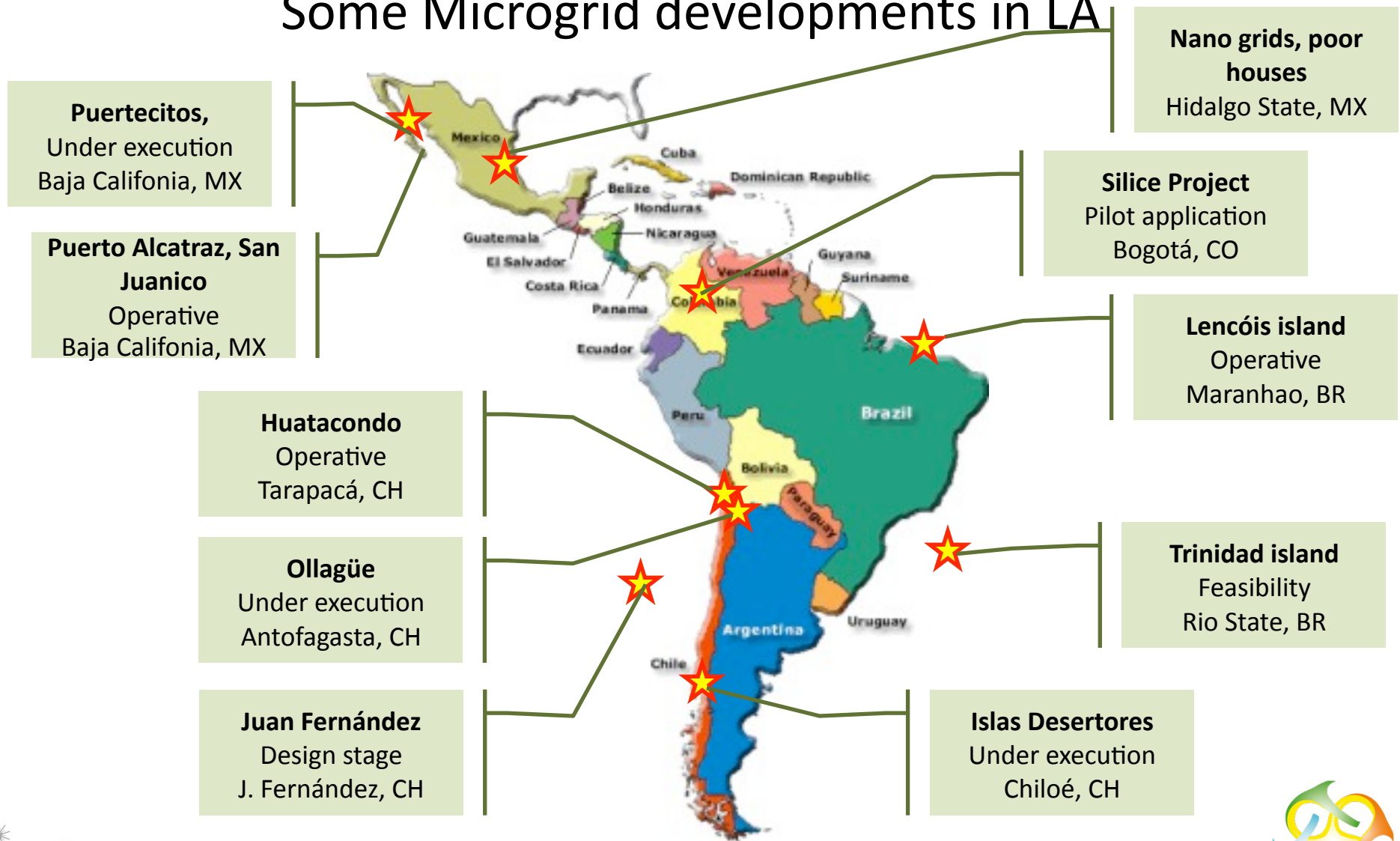
MG operating in islanding way

- Must be able to integrate and coordinate several local energy sources with appropriate load-frequency strategies.
- Active participation of the local community

Source: Denda, Shimizu Corporation

Microgrids opportunities in the region

Some Microgrid developments in LA



Microgrids opportunities in the region

Research Institutions in LA

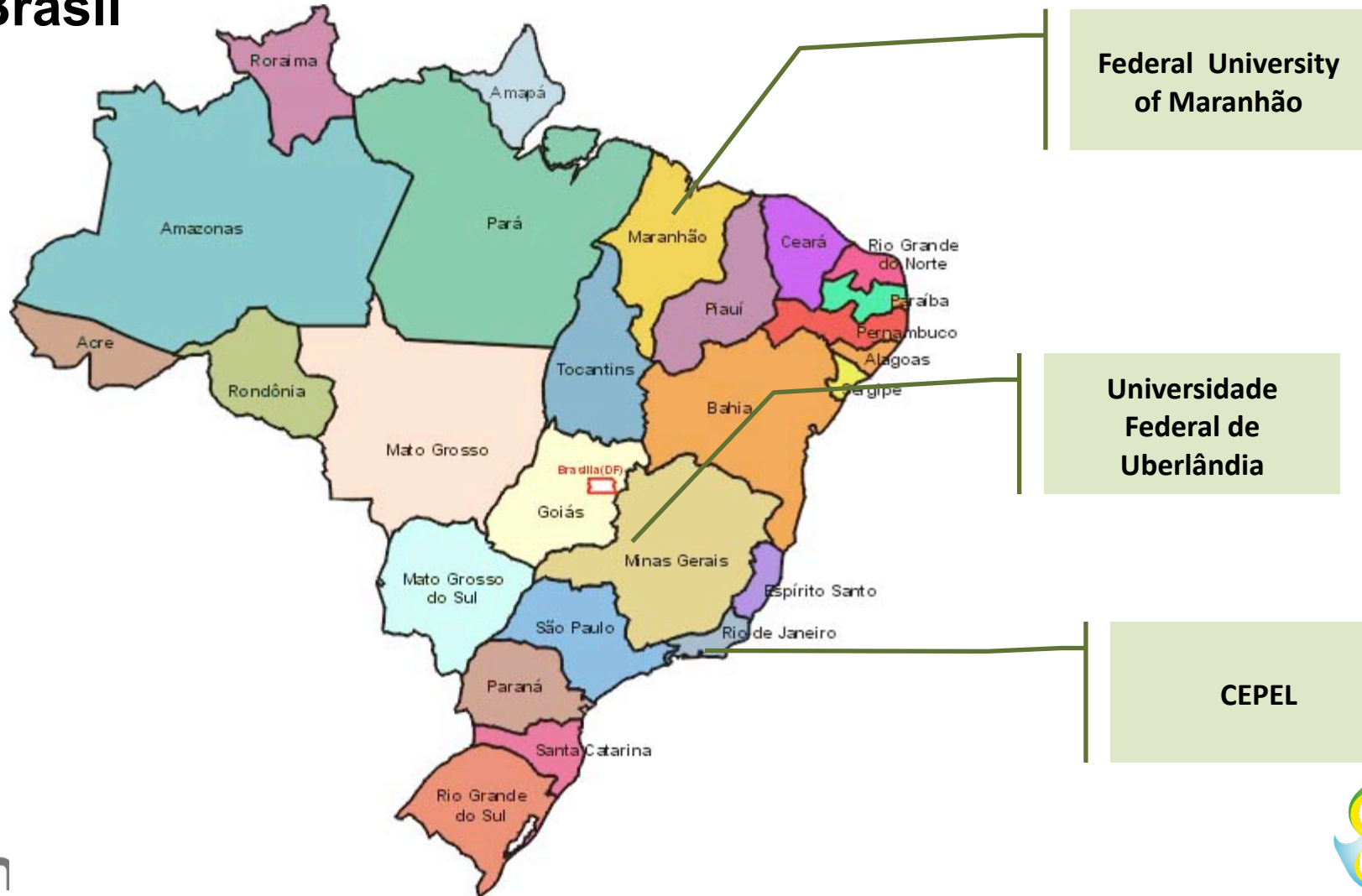
Mexico



Microgrids opportunities in the region

Research Institutions in LA

Brasil



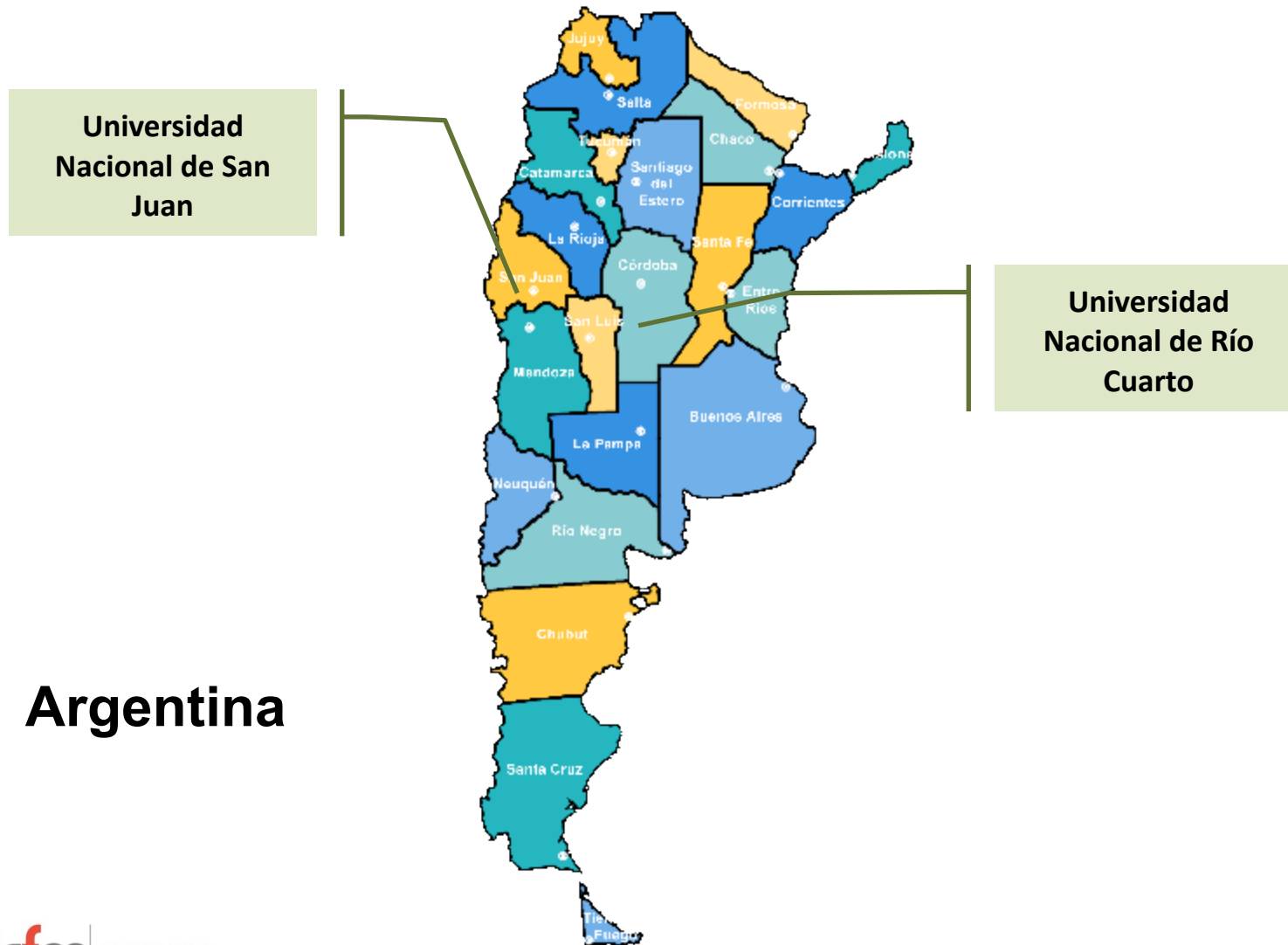
Microgrids opportunities in the region

Research Institutions in LA



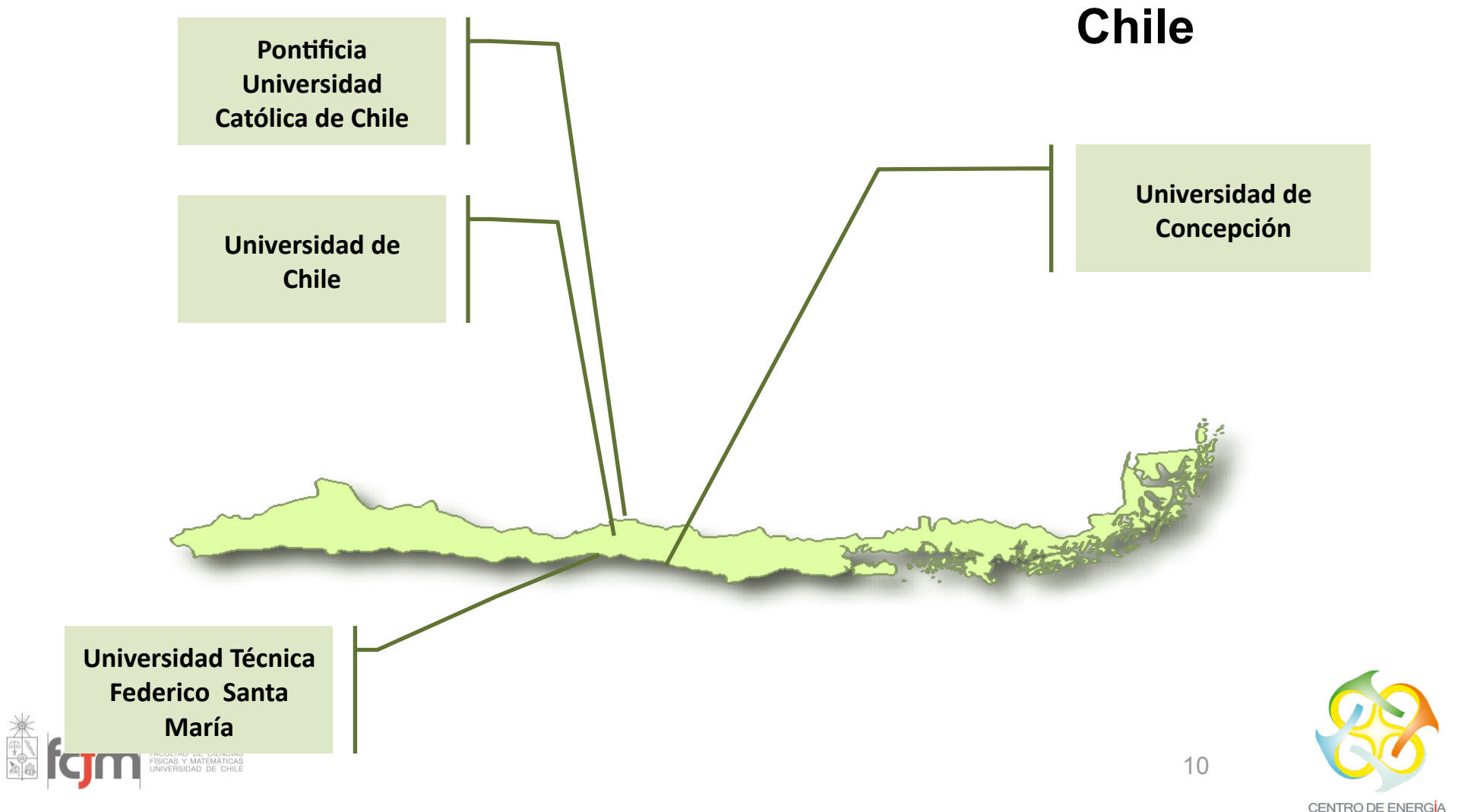
Microgrids opportunities in the region

Research Institutions in LA



Microgrids opportunities in the region

Research Institutions in LA



Microgrids opportunities in the region

Coordinated Micro Grids

Incorporating distributed generation power injections to the current grid

- Coordination platform for a strong control and monitoring of MGs
- Virtual Power Plant

Isolated Micro Grids

MGs operating in islanding way

- Must be able to integrate and coordinate several energy sources with appropriate load-frequency strategies .
- Active participation of the local community

Emergency Micro Grids

Emergency systems

- Locations prone to face natural disasters such as earthquakes, tsunamis, storms, floods.
- It is applicable both for islanding and interconnected application where the energy supply for a sector of the system must be continuous for a wide range of contingencies

Microgrids opportunities in the region

Coordinated Micro Grids

Pilot projects

- Coordination platforms, energy efficiency, balancing , regulatory issues

Isolated Micro Grids

Pilot and applied projects

- Development of appropriate load-frequency strategies , diesel engines adaptation, energy storage systems.
- Local community engagement, community tools

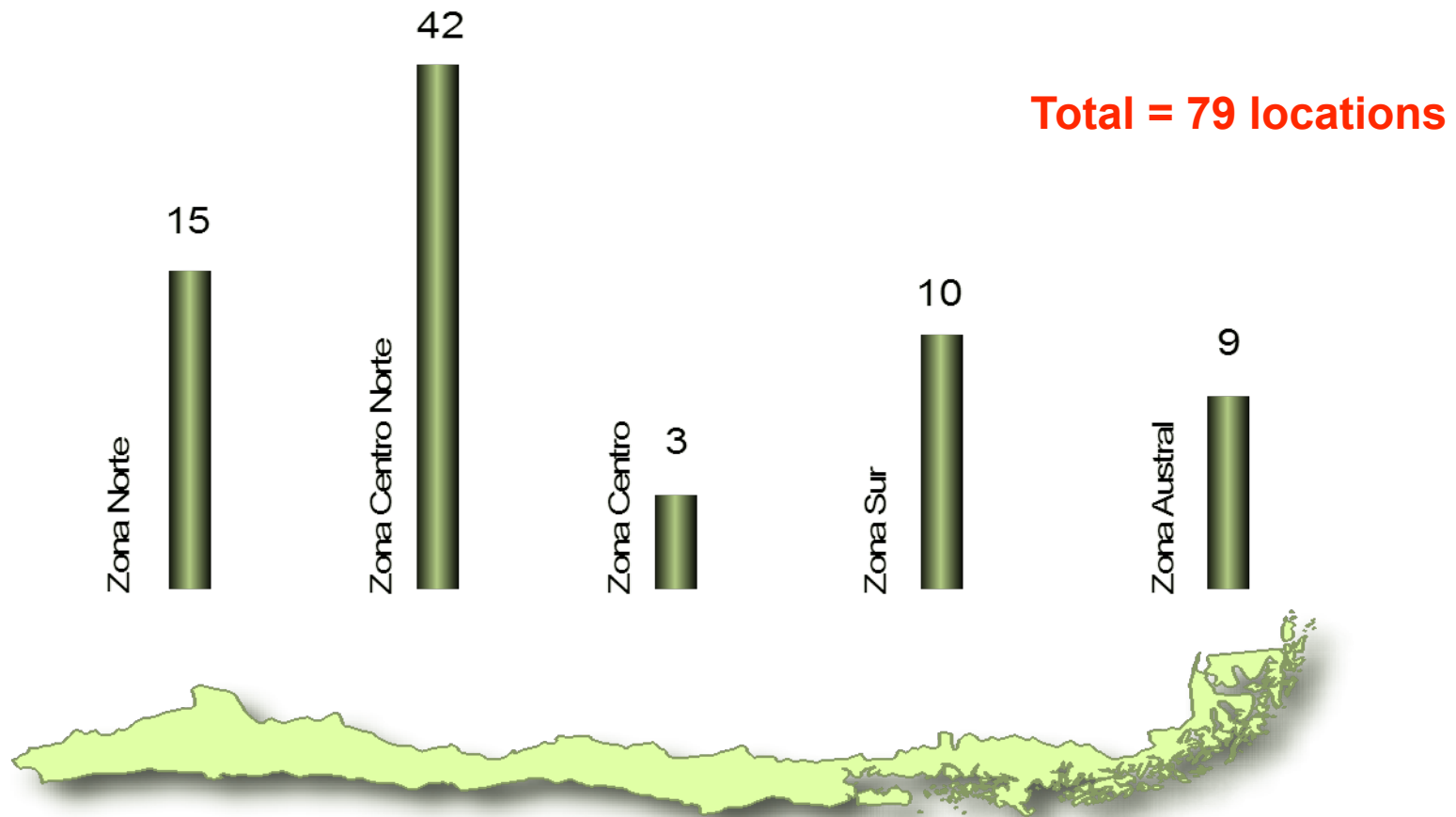
Emergency Micro Grids

Pilot projects

- Robustness, security, applicability to both isolated and coordinated MGs,

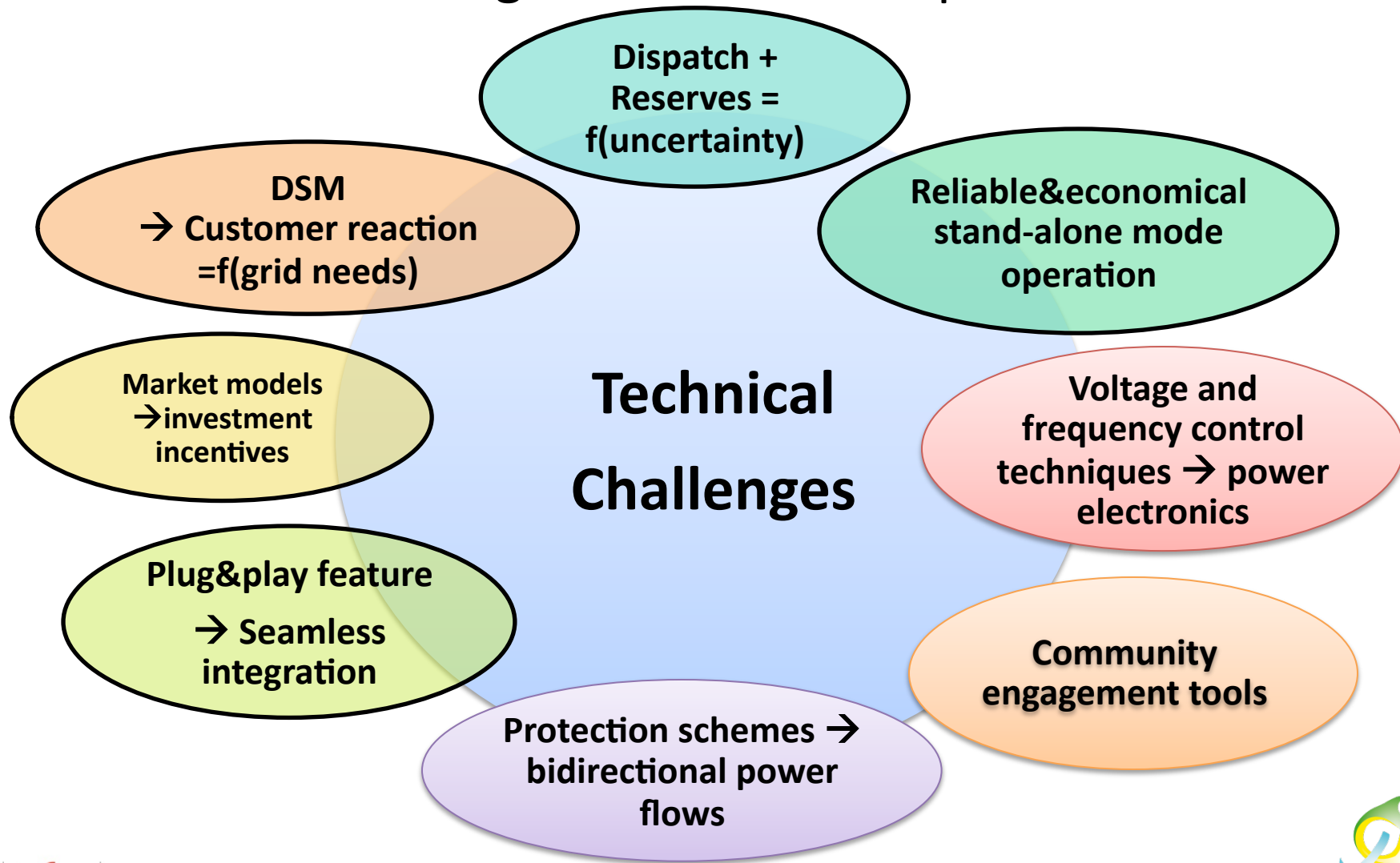
Microgrids opportunities in the region

Chile: Number of feasible isolated MG opportunities



Microgrids opportunities in the region

Challenges for MG developments



Contents

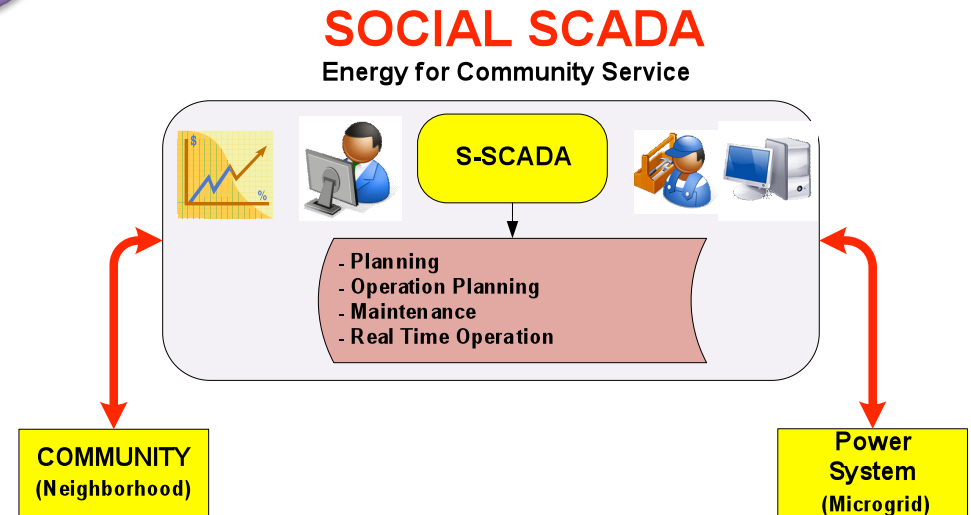
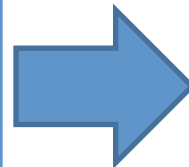
1. Microgrids opportunities in the region
2. Social SCADA and resilience
3. V2G in isolated microgrids
4. Conclusions

Social SCADA and resilience



Its necessary to take into account the interactions between technology and people, as well as consequences.

The introduction of new energy technologies in a rural setting is a challenge, since it generates changes in patterns of energy use and others.

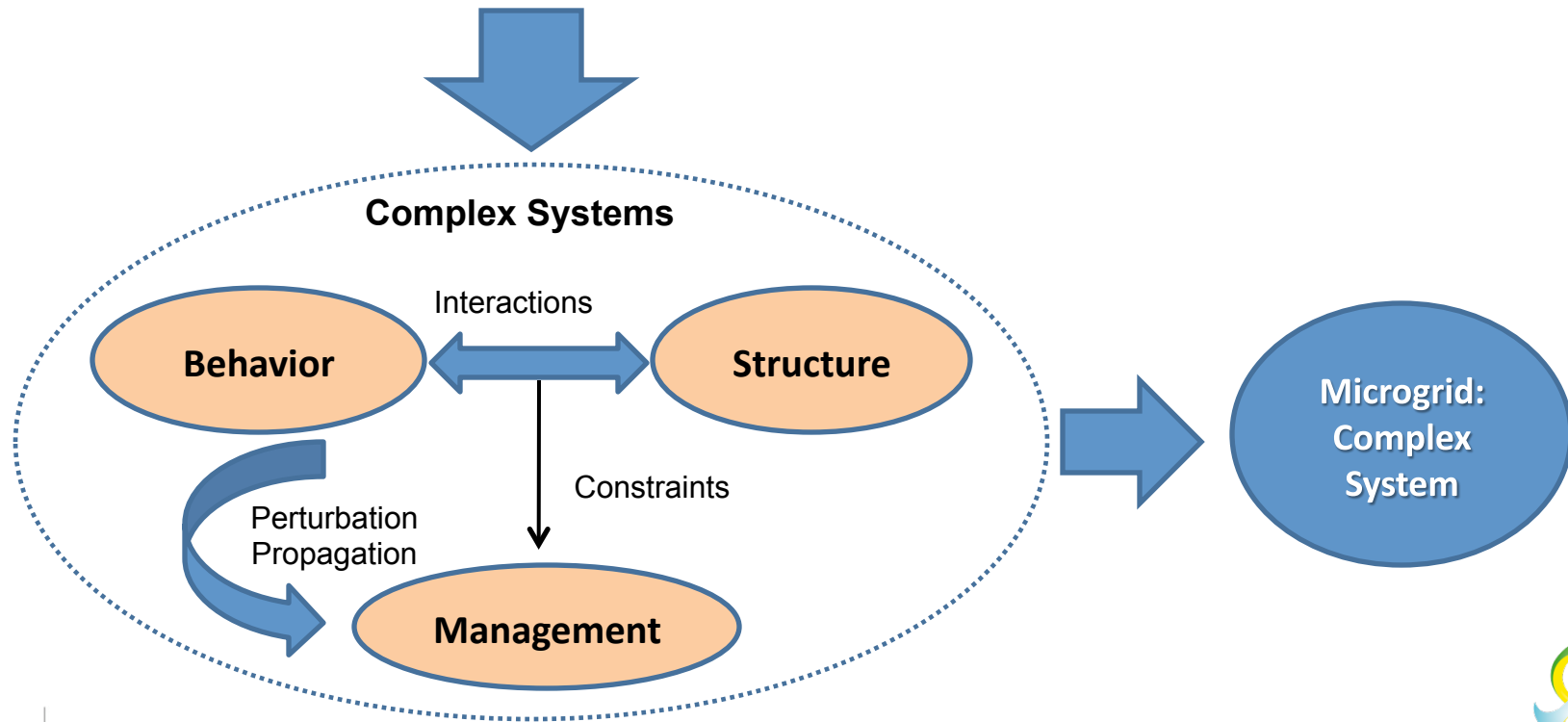


Is S-SCADA an adequate tool to face disruptive events in a isolated microgrid environment?

S-SCADA + Resilience

Social SCADA and resilience - Objective

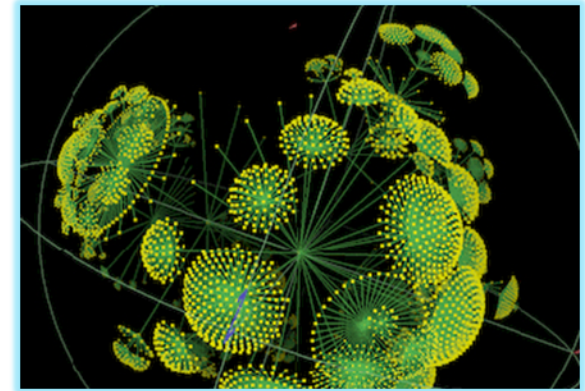
Develop monitoring tools for Microgrids from the perspective of *Resilience*, focused on the sustainability of the system, based on Complex Systems Theory.



Social SCADA and resilience – Complex Systems

Complex System is a generic term used to describe interconnected parts that as a whole exhibit one or more properties not obvious from the properties of individual parts.

Resilience is the capacity of a system to continually change and adapt yet remain within critical thresholds.



Features:

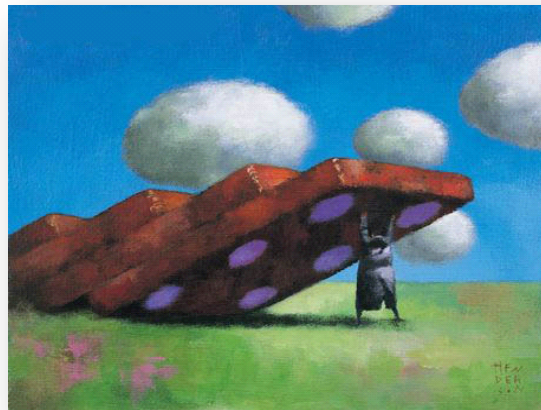
- Difficult to determine boundaries.
- May be open.
- Multiple dynamic.
- Self-organization.
- May produce emergent properties.
- Relationship are non-linear and contain feedback loops.

Social SCADA and resilience

Resilience of a Microgrid

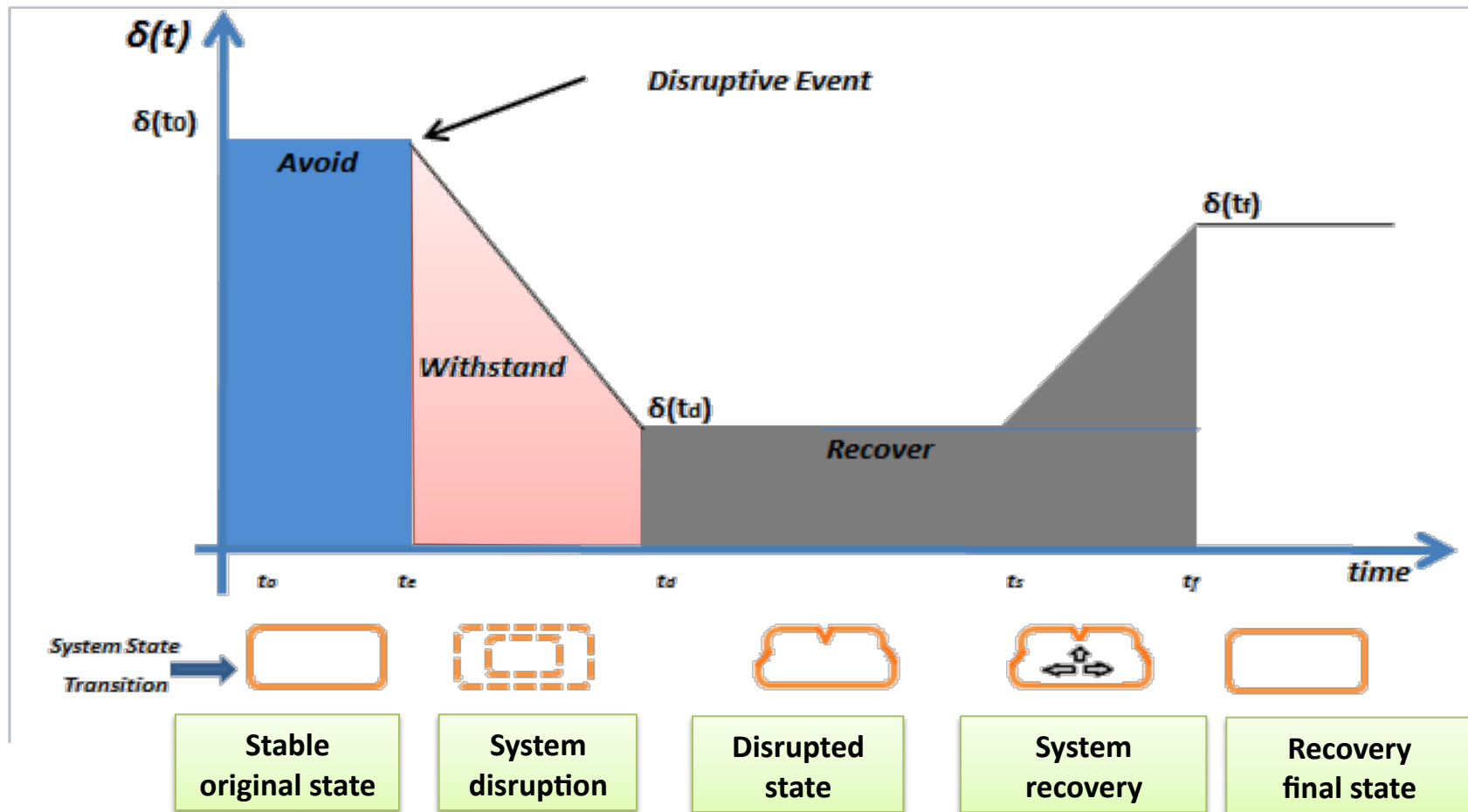
In a micro grid framework resilience may be understood as a measure of the system sustainability.

→ Capacity to absorb social, environmental, technical, and economical changes originated by low probability disruptive events with high impact, while quality of service is maintained.



Social SCADA and resilience

Application of Resilience in Microgrids



Ref: K. Barker, J. Ramirez, C. Rocco, "Resilience-based network component important measures", 2013.

→ Indicators are key for each state

Social SCADA and resilience

Properties of Resilience in Microgrids

I. Avoid

- Key issue at design stage:
 - Robustness / flexibility
 - Technical standards
 - Training program
- Preventive maintenance
- Condition monitoring
- Community feedback

II. Withstand

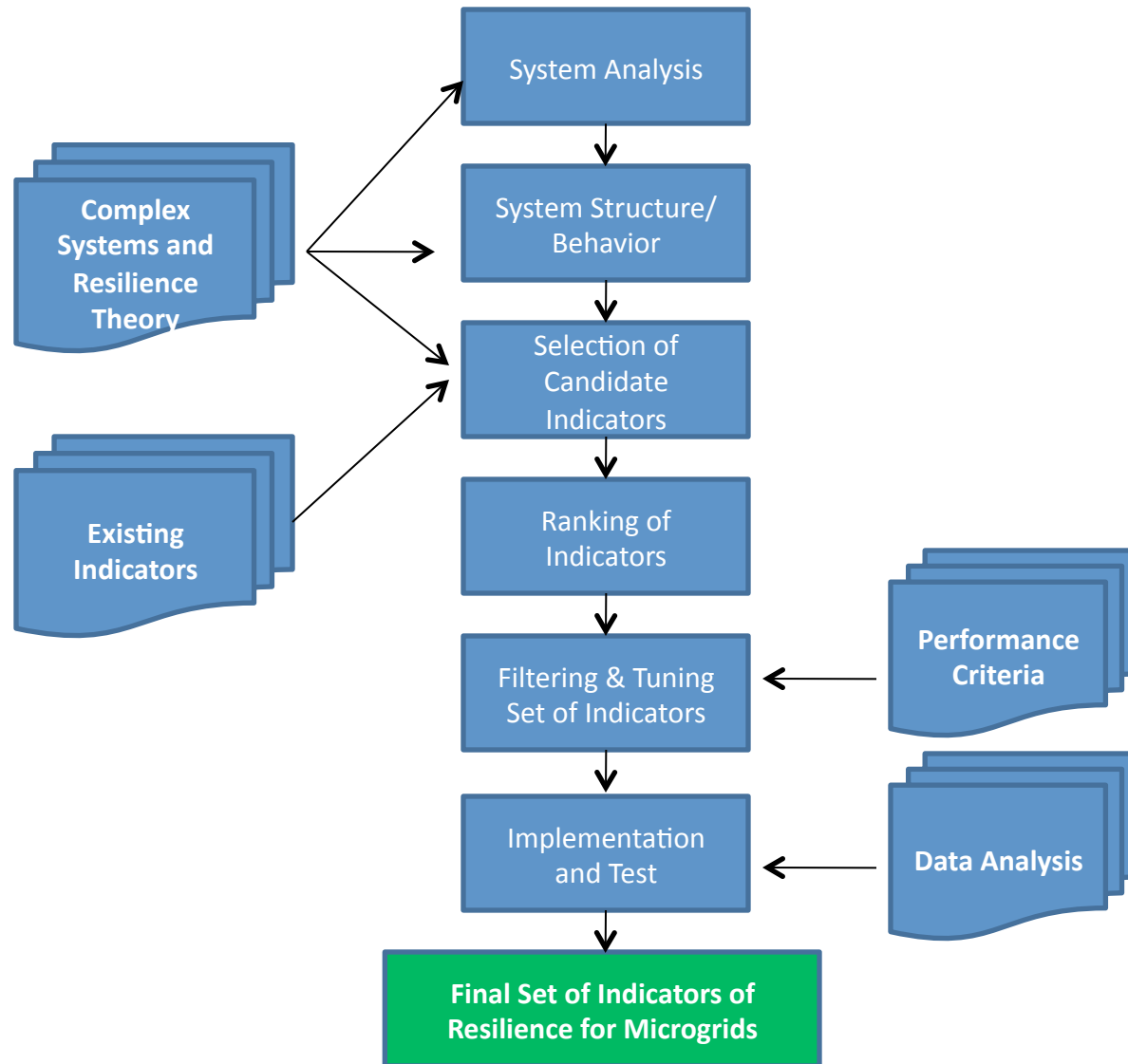
- Provide the system to respond to disturbance without making changes to it:
- Protective / SPSs
 - Reserve margins
 - EMS emergency procedures
 - Community contingency plans

III. Recover

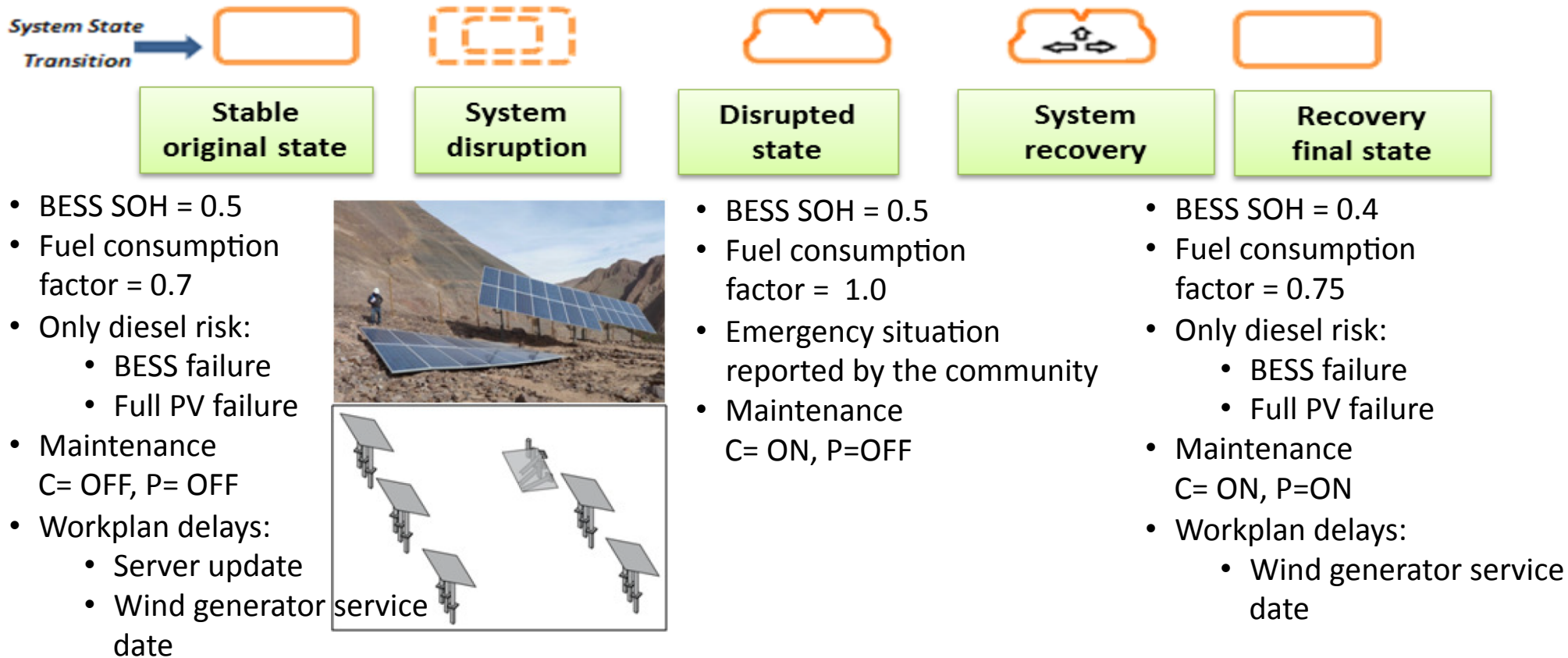
Elimination of disturbance sources:

- Corrective maintenance
- Community recovery contingency plans
- Repairing
- Spare parts management
- Coordination with stakeholders

Development of New Indicators



Study Case: PV Panel Failure



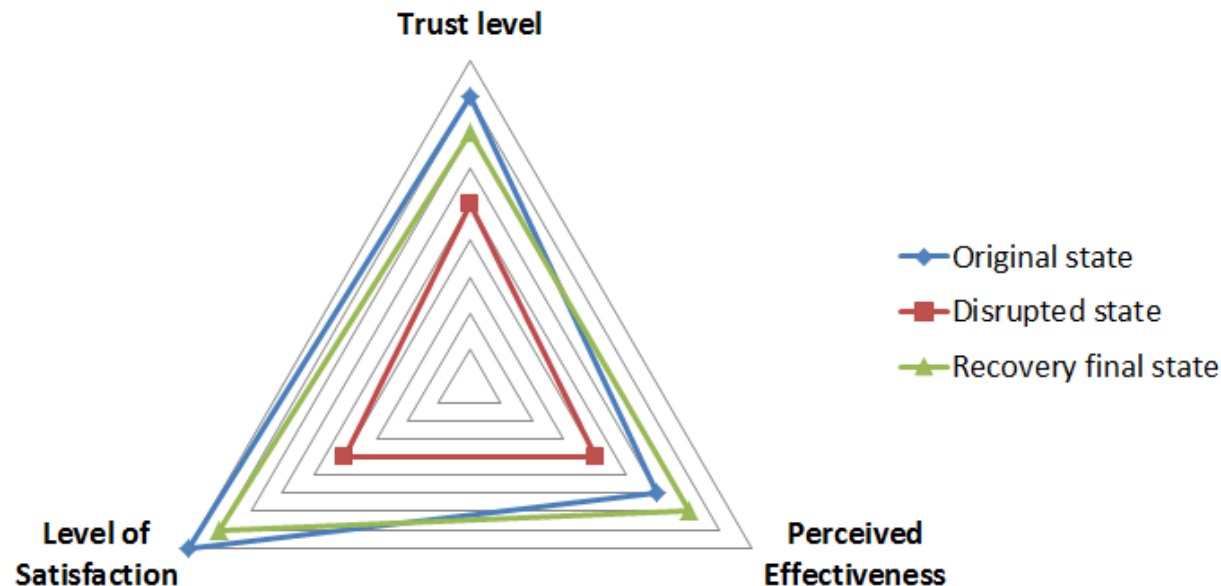
- System reliability decreases
- Increase of community concern
- Severe damage in 1/6 PV array
- Back to full diesel based operation
- Urgent coordination activities among stakeholders
- Coordination activities among stakeholders
- Community concern

Social SCADA and resilience

Social oriented indicators

The Causal-Chain analysis in Community Trust establishes the need to monitor it, in three dimensions: Trust level, Perceived Effectiveness, and Level of Satisfaction

Trust level	Perceived Effectiveness	Level of Satisfaction
Low	Low	Low
Medium	Medium	Medium
High	High	High





Contents

1. Microgrids opportunities in the region
2. Social SCADA and resilience
3. V2G in isolated microgrids
4. Conclusions

V2G in isolated microgrids

Development opportunities

Field	Driver	Green-house gases	Local pollution	Fuel price	Reliability	Noise
<p>V2G opportunities in Chile</p> 	<p>Santiago downtown</p> 					
	<p>Mining area</p> 					
	<p>Rural microgrids</p>					

Huatacondo transportation needs



GARBAGE
COLLECTION

$L = 1.8[\text{km}]$
Max slip = 21.5°
Max load = $200[\text{kg}]$



FARM WORK

$L = 3.4[\text{km}]$
Max slip = 21.9°
Max load = $200[\text{kg}]$



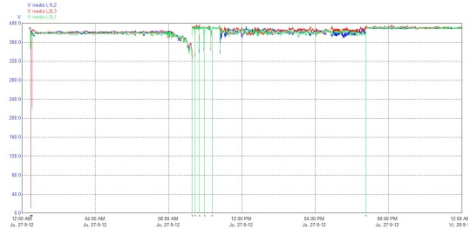
INTERNAL LOAD
TRANSPORTATION

$L = 1.2[\text{km}]$
Max slip = 20.2°
Max load = $200[\text{kg}]$

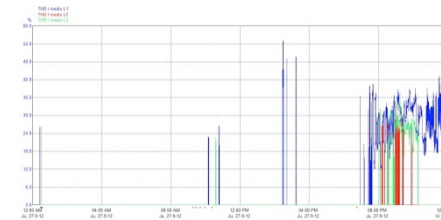
V2G in isolated microgrids

Service cost/quality

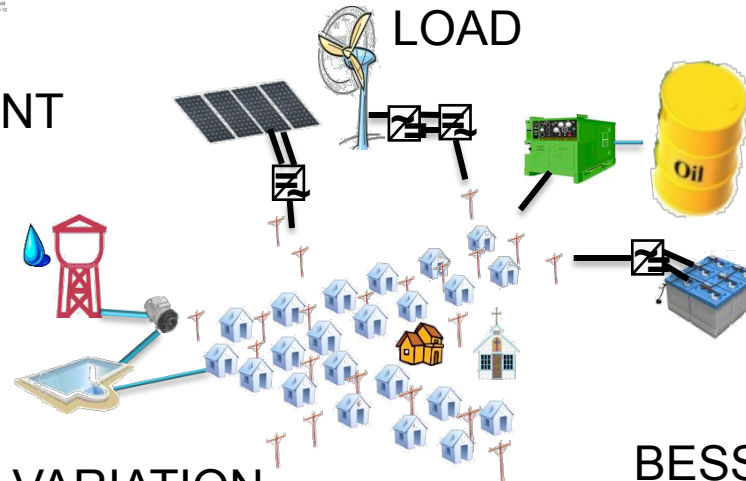
SUDDEN CONNECTION AND
DISCONNECTION OF PV PLANT
AND LOAD



CURRENT THD

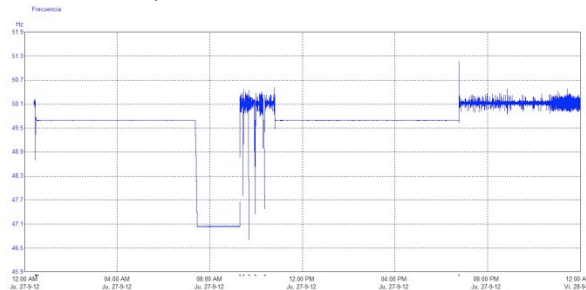


UNBALANCED
LOAD

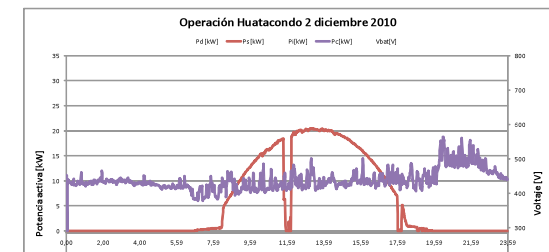


DIESEL
COST

FREQUENCY VARIATION



BESS BACK-UP



V2G in isolated microgrids

Project Stages

DESIGN AND BUILD OF A FOUR-WIRE THREE-PHASE
INVERTER CAPABLE TO:

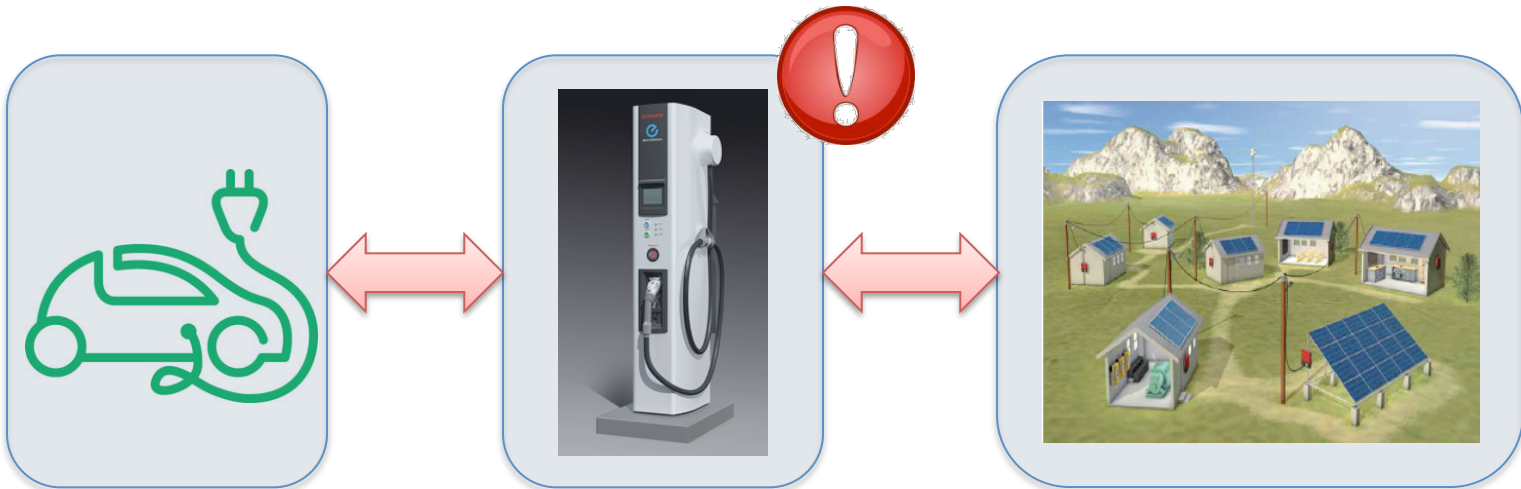
Allow power
conditioning

Drive a three phase
induction machine and
supply 3ph loads

Connected to a
three phase grid

Allow
bidirectional
power flow

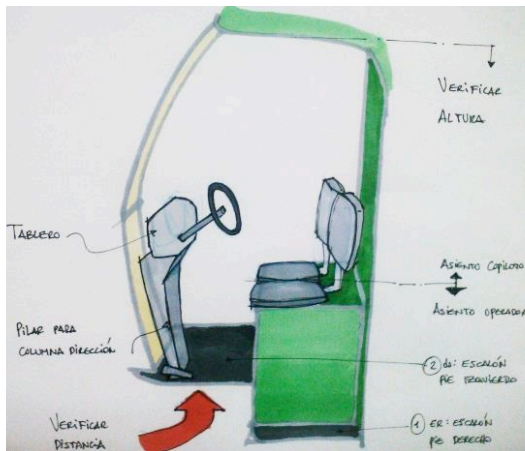
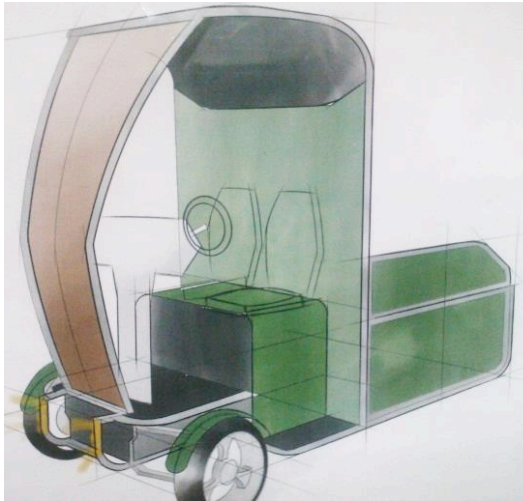
BESS
back-up
capability



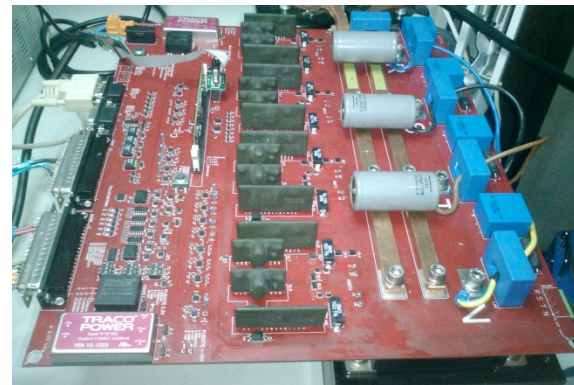
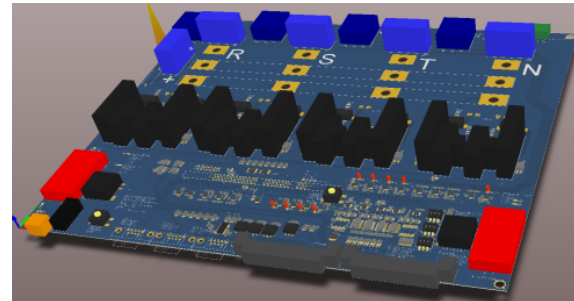
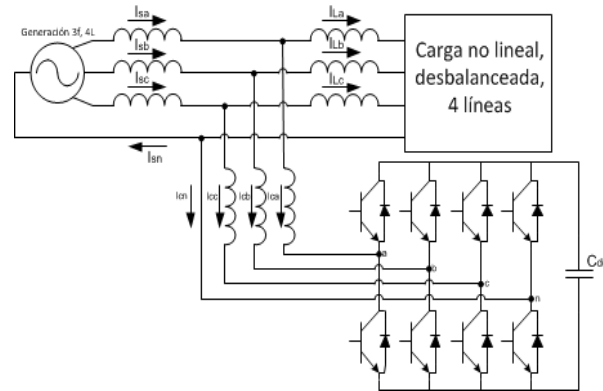
V2G in isolated microgrids

Some results

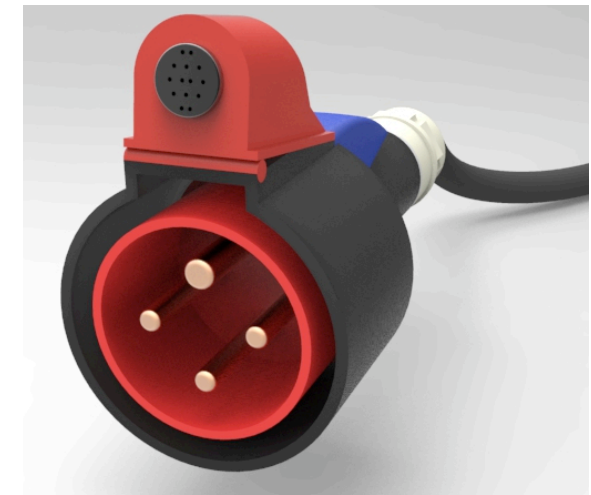
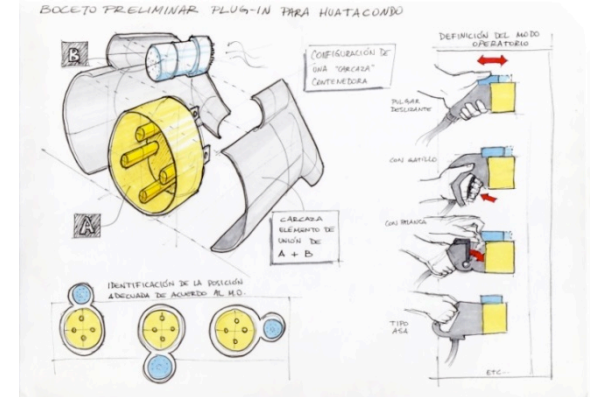
UTILITY AND COMMUNITY ELECTRIC VEHICLE

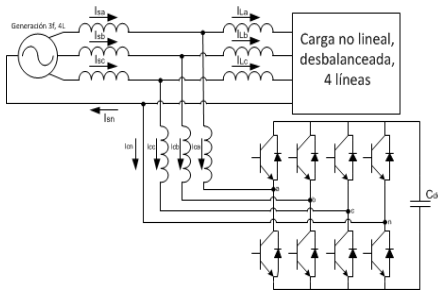


V2G POWER CONVERTER



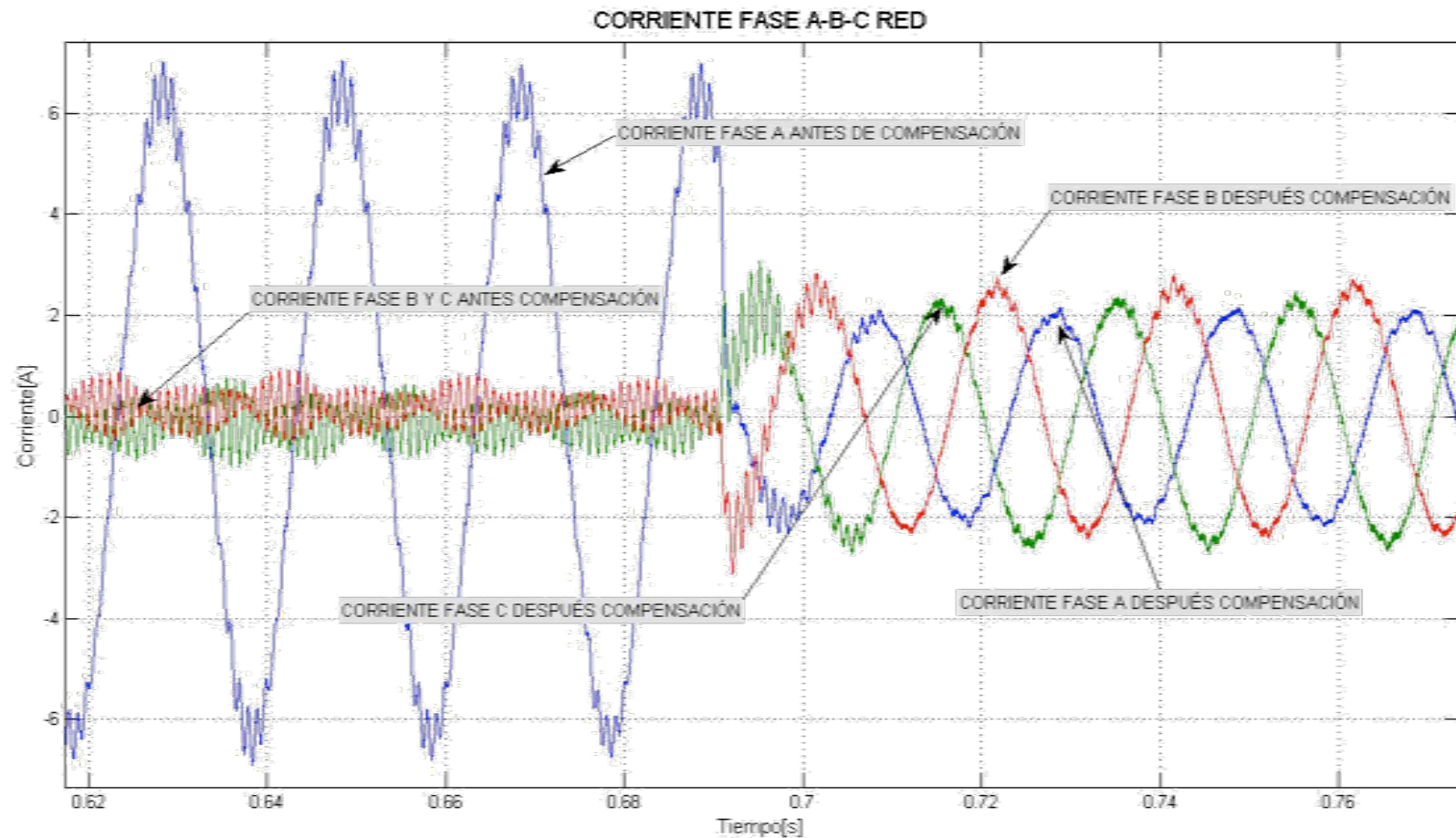
MICROGRID INTEGRATION





V2G in isolated microgrids

Some results



Contents

1. Microgrids opportunities in the region
2. Social SCADA and resilience
3. V2G in isolated microgrids
4. Conclusions

Conclusions

- Microgrids appear as a sustainable solution for rural electrification challenges in LA:
 - To maximize lifetime of equipment
 - Low operation costs
 - Low maintenance cost
- Solutions should be faced from two main approaches: technical and social.
- Resilience indicators should improve the performance of microgrids in rural areas.
- Rural microgrids offer a development opportunity for V2G solutions.

2013 Santiago Symposium on Microgrids

Survey of Microgrid R&D in Latin America

Rodrigo Palma Behnke
Guillermo Jiménez Estévez
Oscar Núñez Mata
Ignacio Polanco
Felipe Valencia Arroyave
Doris Sáez
Pablo Medina
Carlos Silva